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TITLE: Improved Reading and Writing Scheme for a Vortex File Memory. December 1982.

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4p. Vortex file memories using storage and transportation of vortices in Type II superconductors have been proposed, promising potentially high data rates as well as high density. In these schemes the vortices are manipulated in a manner analogous to magnetic bubbles. For example, a major-minor loop organization is one method by which writing and nondestructive reading can be carried out. This method requires that the transfer of bits (vortices) be carried out by special complex geometrical configurations and vortex guiding structures, and depends on ideal material properties, especially with regard to pinning sites. - It is proposed to simplify the organization of the vortex memory and eliminate possible material constraints, such as pinning forces, imposed on the vortex guiding structures. The memory is shown in Fig. 1, in which an array of circular holes 12 is made in the ground plane 10, with diameter and period chosen such that a Josephson weak link 14 is created between two adjacent holes. Circular holes 12 are storage sites for vortices since they represent regions of lowest energy (potential wells). Each weak link between two potential wells presents a potential barrier to the stored vortices in those wells. This potential barrier can be eliminated when the weak link switches to the voltage tate. Vortex generators

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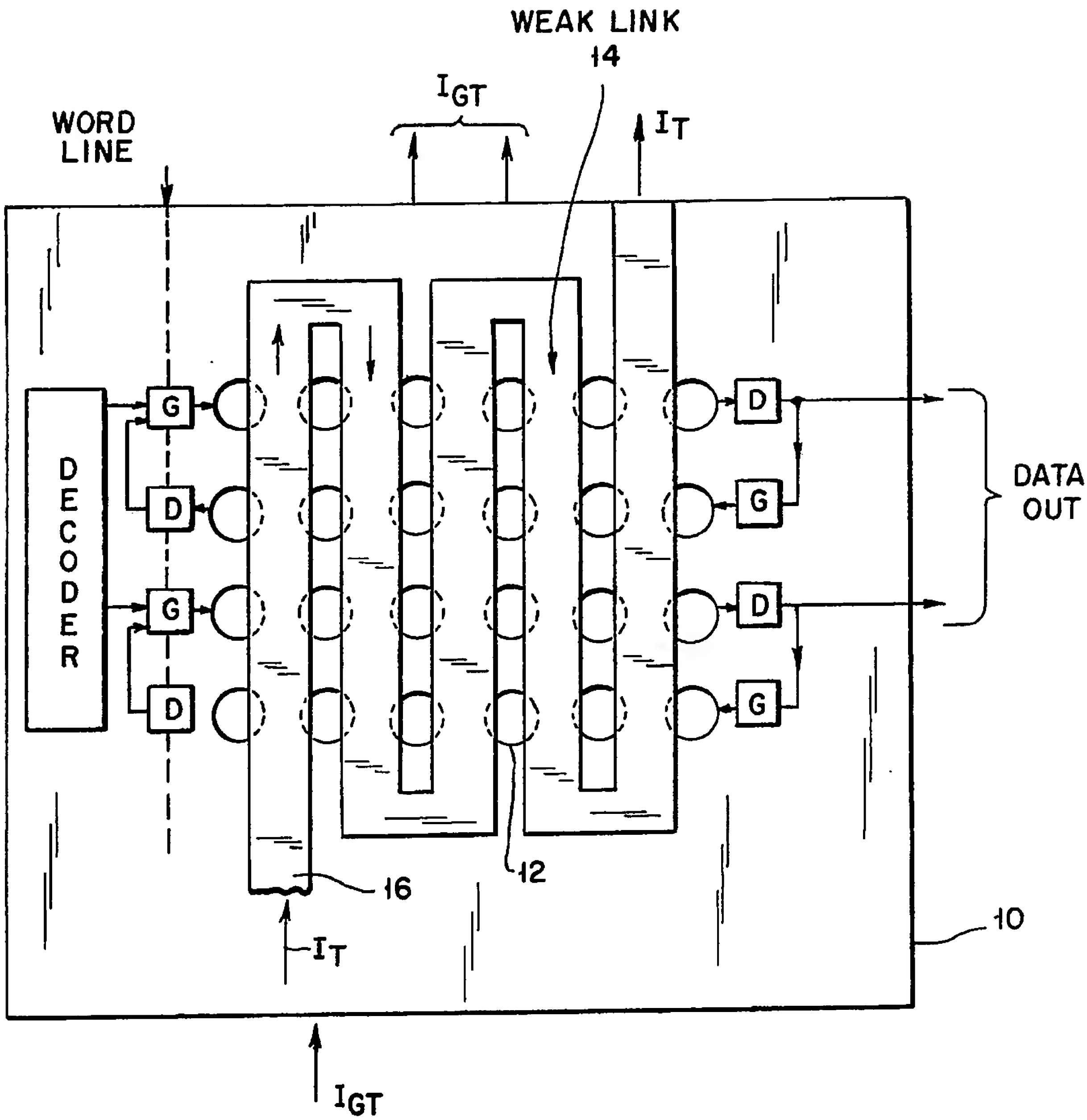
G and detectors D write and read the vortices. - The meandering control line 16 carries a transport current I(T). Current I(GT) also flows in the ground plane through the weak links. When a weak link carries I(T) and I(CIR) (for a stored vortex) and I(GT), its threshold is exceeded, its barrier is lowered, and the Lorentz force moves the vortex to an adjacent potential well where it encounters a high potential barrier to prevent it from moving further. The higher potential barrier is created due to the fact that I(T) is now flowing in the opposite direction. (Zig-zagging control line 16 causes the current to flow in opposite directions between adjacent wells.) Thus, the Lorentz force acts in a direction opposite to that of the previous vortex motion. - Fig. 2 is a side view showing a cross-section of the ground plane 10, holes 12, and control line 16. Current I(T) is flowing in a direction perpendicular to the vortices Phi(O), and both are perpendicular to the direction of motion. An illustration is given of how vortices enter and exit the ground plane and the general shifting of these vortices from left to right in Figs. 3A and 3B.
For example, in the positive phase of the first cycle, the vortex which was stored in the first well moved to the second well after having switched the weak link and lowering the barrier. This same vortex is stable in the second well and cannot move further to the right because it experiences a force from right to left (high barrier). The weak link, which already switched, resets and becomes another high barrier to the vortex, preventing it from moving from right to left. Therefore, the vortex is stable in the second well. The negative phase of the first cycle disturbs this stable condition, causing

vortices to move to adjacent wells to the right. - This stepwise motion is illustrated in Fig. 3B for three cycles. This mechanism for transporting vortices is different from previously proposed schemes in that it relies on (1) weak link switching properties and Lorentz force for transport, and (2) holes, and not conducting materials, for storage. These two features eliminate the constraints imposed on previous schemes and make the vortex file memory both practical and feasible. - To read non-destructively, a combination of vortex detectors D and vortex generators G is used, as shown in Fig. 4. This scheme allows each detected vortex in one row to be simultaneously rewritten in the row below it. These two rows then effectively form a "loop" without resorting to special geometrical configurations as in previous schemes, to achieve the same result. This arrangement for non-destructive reading leads to a simple flip-flop concept, which may be used for a vortex driven latch.

FIG. 1



WEAK LINK
14
I_{GT}
I_T
WORD
LINE
DECODER
G
D
G
D
D
G
D
G
DATA
OUT
16
12
I_T
10
I_{GT}

FIG. 2

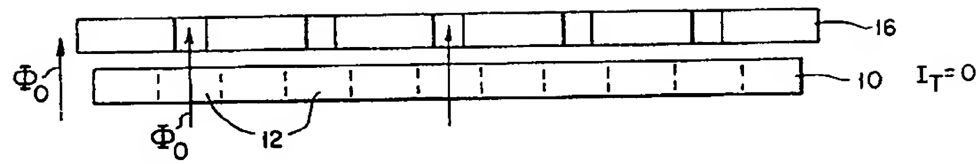


FIG. 3A

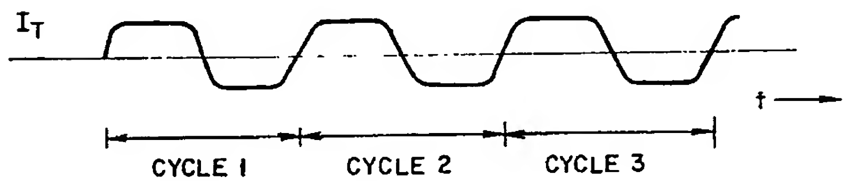


FIG.3B

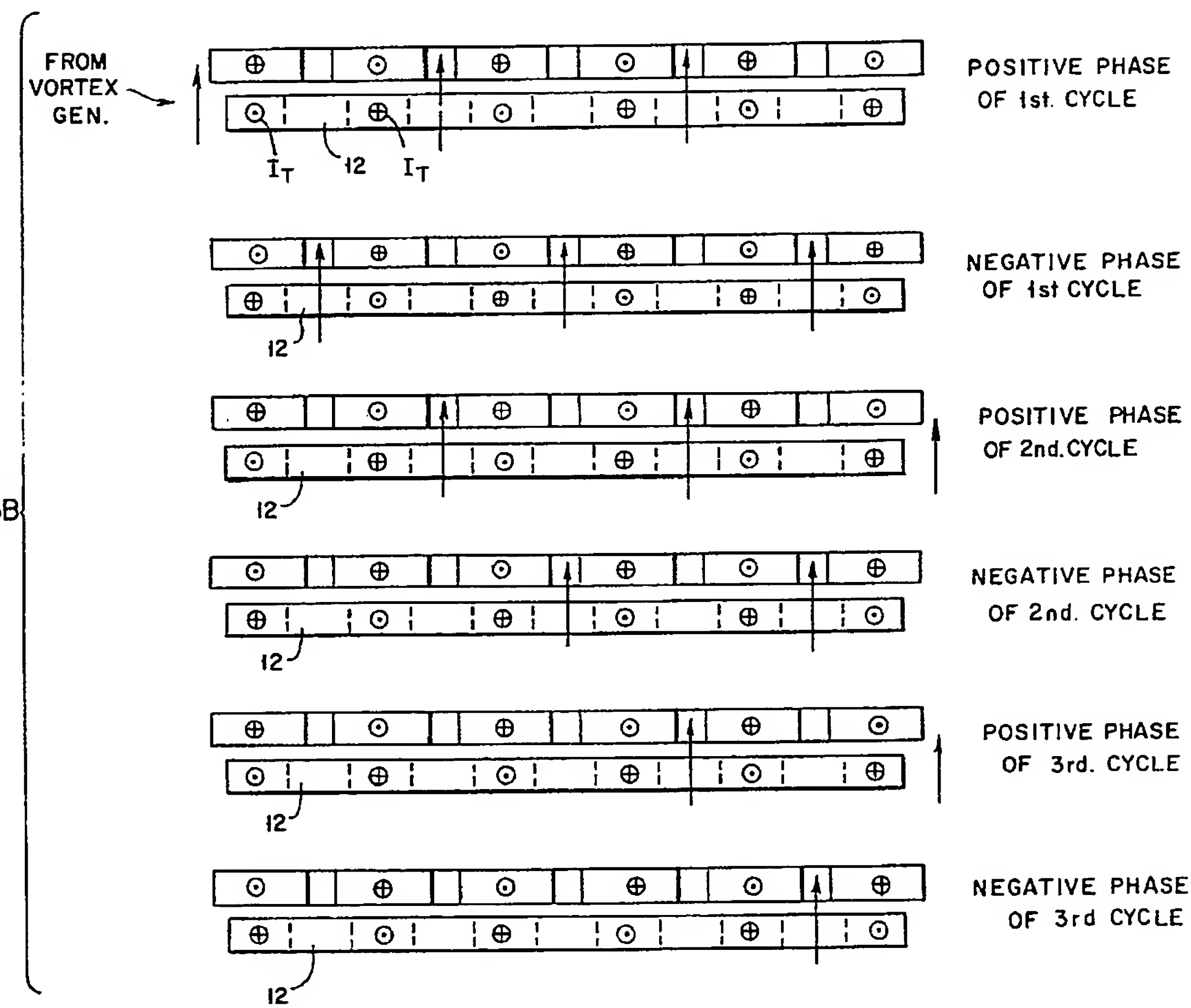


FIG. 4